CLASS VI AOR BOUNDARY CONDITIONS DESCRIPTION

INJECTION WELL 357-7R
ELK HILLS A1-A2 PROJECT

AoR Boundary Conditions

Elk Hills A1-A2 Site Geology and Hydrology

The Northwest Stevens Field is a northwest-southeast trending anticlinal structure located in the Elk Hills Oil Field within the San Joaquin Valley of California, producing oil and gas from the Miocene-aged Monterey Formation. The reservoir sands are composed of a series of stacked turbidite sands, interbedded with siliceous shales and clays. The Monterey Formation A1-A2, present in the northwestern portion of the field, pinch out towards the southeast (Figure 1, cross-section A-A') and compares to the crest, the reservoir quality is lower on edges of the structure (Figure2).

The Monterey Formation sands are bound above by the regional Reef Ridge Shale, and below by the Lower Antelope Shale Member of the Monterey Formation. The Reef Ridge Shale is a deep marine, clay-rich interval, deposited regionally with average gross thicknesses of ~1,000', and has a very low matrix permeability. Its competence in confining upward fluid movement is established by its demonstrated historical performance as the regional seal for hydrocarbon accumulation within the Monterey Formation, not only for the Monterey Formation A1-A2, but for all Monterey accumulations in the greater Elk Hills area.

Figure 1: Cross-section A-A' showing the Monterey Formation A1-A2 sands. Note the increasing shale content on the edges of the structure.

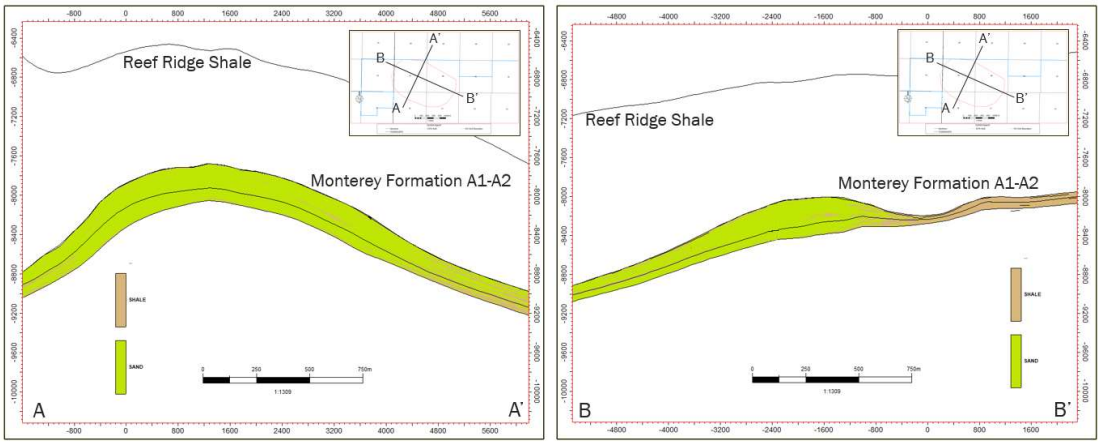
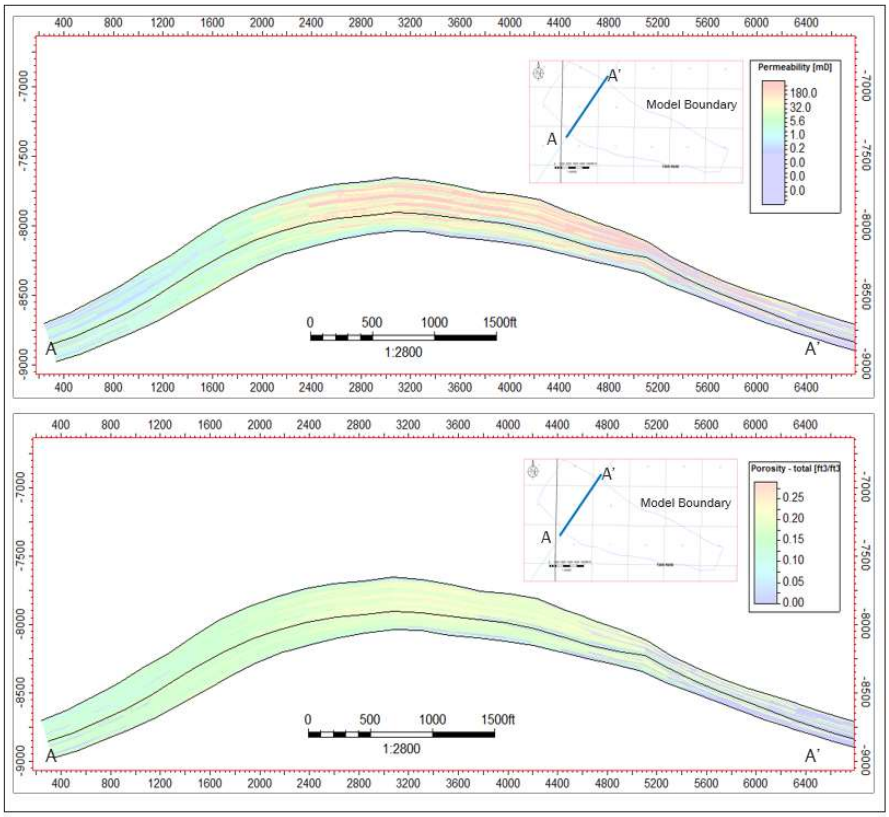


Figure 2: Reservoir quality of the Monterey A1-A2 reservoir. Note the reduction in porosity and permeability of the edges of the anticline structure.



Reservoir Development

The CalCapture Class VI injection wells will target injection in the Monterey Formation A1-A2 sands. The Monterey Formation A1-A2 oil and gas reservoir was discovered in the 1970's and has been developed with primary production and pressure maintenance (Table 1). Gas and water injection initiated in 1982 supported reservoir pressures and helped maintain oil production. Starting in the year 2000, pressure maintenance ceased, and the gas cap reservoir was "blown-down", depleting the reservoir pressure. Since blow-down, reservoir pressure has remained at 200-300 PSI, indicating a closed reservoir with minimal water influx and/or connection to an aquifer.

Table 1: Production and injection volumes for the Monterey Formation A1-A2 reservoir.

Process	Phase	Volume
Production	Oil	28 million barrels
	Gas	193 billion cubic feet
	Water	9 million barrels
Injection	Water	6 million barrels
	Gas	175 billion cubic feet

Boundary Conditions

No-flow boundary conditions were applied to the Monterey Formation A1-A2 reservoir in the computational modeling. These conditions were based on the following:

1. The overlying Reef Ridge Shale is continuous through the area, has a low permeability (less than 0.01 mD) and has confined oil and gas operations, that include the injection of water and gas, since discovery.

2. Performance data from operating the Monterey Formation A1-A2 oil and gas reservoir indicates no connection to an active aquifer.

    i. Historical production data (Figure 3) shows minimal water production, supporting limited aquifer influx.

    ii. Gas injection and subsequent gas blow-down (Figure 3) proves lateral and vertical confinement by demonstrating that gas did not migrate out of the reservoir.

    iii. Pressure in the reservoir is 200 - 300 PSI, demonstrating minimal to no aquifer influx and subsequent increase in pressure.

Figure 3: Monterey Formation A1-A2 production and injection data.